

SCENARIO #2

CARBON MONOXIDE INCIDENT IN AN AUTO SHOP



FIGURE 8-8

A 500 gallon ASME propane tank is used to supply an interior space heater at an automobile repair shop. During extremely cold weather, the shop's mechanics park cars needing repair the next day inside the garage before they go home so they will be warm and ready for work the next shift. The garage's interior space heater thermostat is normally set on 70°F.

At 6:30 A.M., the first mechanic arrives at the shop and makes a pot of coffee. About 15 minutes after arrival, the mechanic becomes dizzy and sits down on a chair to rest. He subsequently goes unconscious and falls to the floor.

At 6:45 A.M., the second mechanic arrives at work, enters the garage, and finds his partner unconscious on the floor. He tries to awaken his partner but gets no response. The second mechanic dials 911 for an ambulance.

At approximately 6:55 A.M. a fire department ambulance arrives on the mechanics. One EMT begins to feel dizzy, and a decision is made to leave the building immediately and call for additional assistance.

The call for assistance brings a Command Officer, an Engine Company, an Advanced Life Support Unit (ALS), and a Rescue Squad to assist the EMTs already on scene. Upon arrival, the EMTs brief the Incident Commander on the possible carbon monoxide atmosphere and the location of the mechanics inside the building.

SUMMARY OF CONSTRUCTION FEATURES

A 500 gallon ASME horizontal storage tank can be equipped with either a single stage or two-stage regulator system, although two stage regulation systems are now required on new installations. The regulator(s) are designed to decrease the gas vapor pressure from the variable container pressure to the lower pressure required to safely operate the appliance. In this scenario the appliance is an interior space heater. See Figure 8-9.

Most gas appliances like furnaces require venting systems to properly discharge products of combustion to the exterior of the building. If appliances and venting systems malfunction due to age or poor maintenance, there is a risk that combustion products can vent to the interior spaces of the building. Carbon monoxide (CO) is a major by-product of incomplete combustion.

According to the American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) (Ventilation Standard 62–89), a concentration of no more than 9 parts per million (ppm) of CO is permissible in residential living spaces.

INCIDENT ACTION PLAN

TACTICAL OBJECTIVES

The primary tactical objective is to rescue the mechanics who have been overcome with carbon monoxide, secure ignition sources, and ventilate the interior of the building.

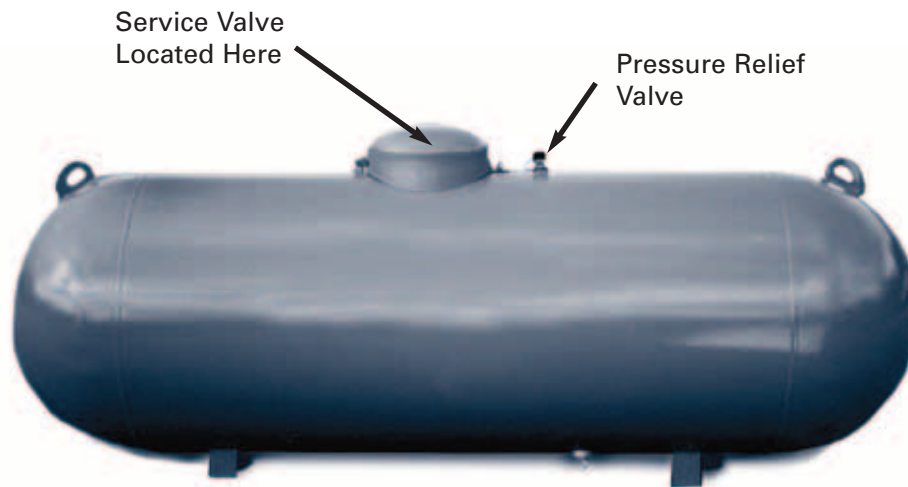


FIGURE 8-9 Construction features of ASME 500 gallon tank.

METHODS OF SECURING THE BUILDING AND ISOLATING THE PROBLEM

The Incident Commander (IC) assigns the Rescue Squad to enter the building in full protective clothing and SCBA to locate and remove the two mechanics trapped in the garage. One member of the rescue team takes a tri-gas monitoring instrument with him that measures flammability, oxygen deficiency and enrichment, and carbon monoxide.

As the rescue team enters the garage, the tri-gas meter's CO alarm activates. The CO reading is 800 parts per million (ppm).

While the rescue team is making entry for an emergency rescue, the IC orders the Engine Company to establish a water supply and deploy a charged handline as a precautionary measure. One person is directed to close the service valve on the 500 gallon propane tank to isolate and shut down the fuel supply to the heater. See Figure 8-9.

After the mechanics are removed from the building, paramedics establish an airway and begin administering supplemental oxygen at the highest possible concentration. Both patients are treated for shock and transported to the hospital by ambulance. The EMT who felt dizzy will be checked for CO poisoning at the hospital.

Additional factors to consider for this operation include:

- **It should be recognized that neither the 500 gallon propane tank nor the propane system is the cause of the carbon monoxide problem; rather it is the space heater that has not been properly maintained and is malfunctioning.**

Closing off the supply of propane will shut down the heater, which will stop the production of carbon monoxide. However, only time and proper ventilation of the area will reduce the carbon monoxide in the air to safe levels. Carbon monoxide build-up in a closed, poorly ventilated area takes time. In the scenario used, the garage was closed up for 12 hours with the space heater in almost continuous operation. Note that a typical home has air exchange rates of about 0.5 air exchanges per hour (ACH).

- Because carbon monoxide gas is odorless, colorless, and tasteless, it cannot be detected by body senses. Carbon monoxide can only enter the body through the respiratory system. Inhaled carbon monoxide is absorbed into the blood and then combines with the hemoglobin of the blood to exclude oxygen. Symptoms of exposure include headache, nausea, chronic fatigue, confusion, and dizziness. The harmful effects of CO exposure depend on the concentration of the gas in the air, exposure time, and factors such as age, health, size, and sex.
- According to NIOSH, the maximum allowable concentration for continuous exposure to carbon monoxide in any 8-hour period (TLV-TWA) is 35 ppm (0.0035%). At 1,200 ppm, carbon monoxide is considered Immediately Dangerous to Life and Health (IDLH). At 800 ppm, the initial reading used in this scenario, a person would experience a headache in 10 minutes after exposure and death in 40 to 45 minutes. See Figure 8-10. [Source UL-2034, Page A19, Figure 38.1]
- It is important to note that carbon monoxide is flammable and has a wide explosive range! The Lower Flammable Limit for CO is 12.8% (128,000 ppm) and the Upper Flammable Limit is 74% (740,000 ppm). Note in Figure 8-10 that a CO reading of 10,000 ppm would be 1% of the atmosphere or 7.8% of the Lower Flammable Limit; this would be within the safety limit for conducting a rescue in an indoor area using full protective clothing and SCBA.
- Many Emergency Medical Systems have formal protocols established for carbon monoxide poisoning whereby patients suffering from CO poisoning are transported to hospitals equipped with hyperbaric oxygen therapy facilities. When carbon monoxide poisoning is suspected, consideration should be given nearly in the incident to transporting the patient directly from the scene to a hyperbaric therapy facility. Speed is of greatest importance.

Concentration Levels and Physiological Effects of Carbon Monoxide

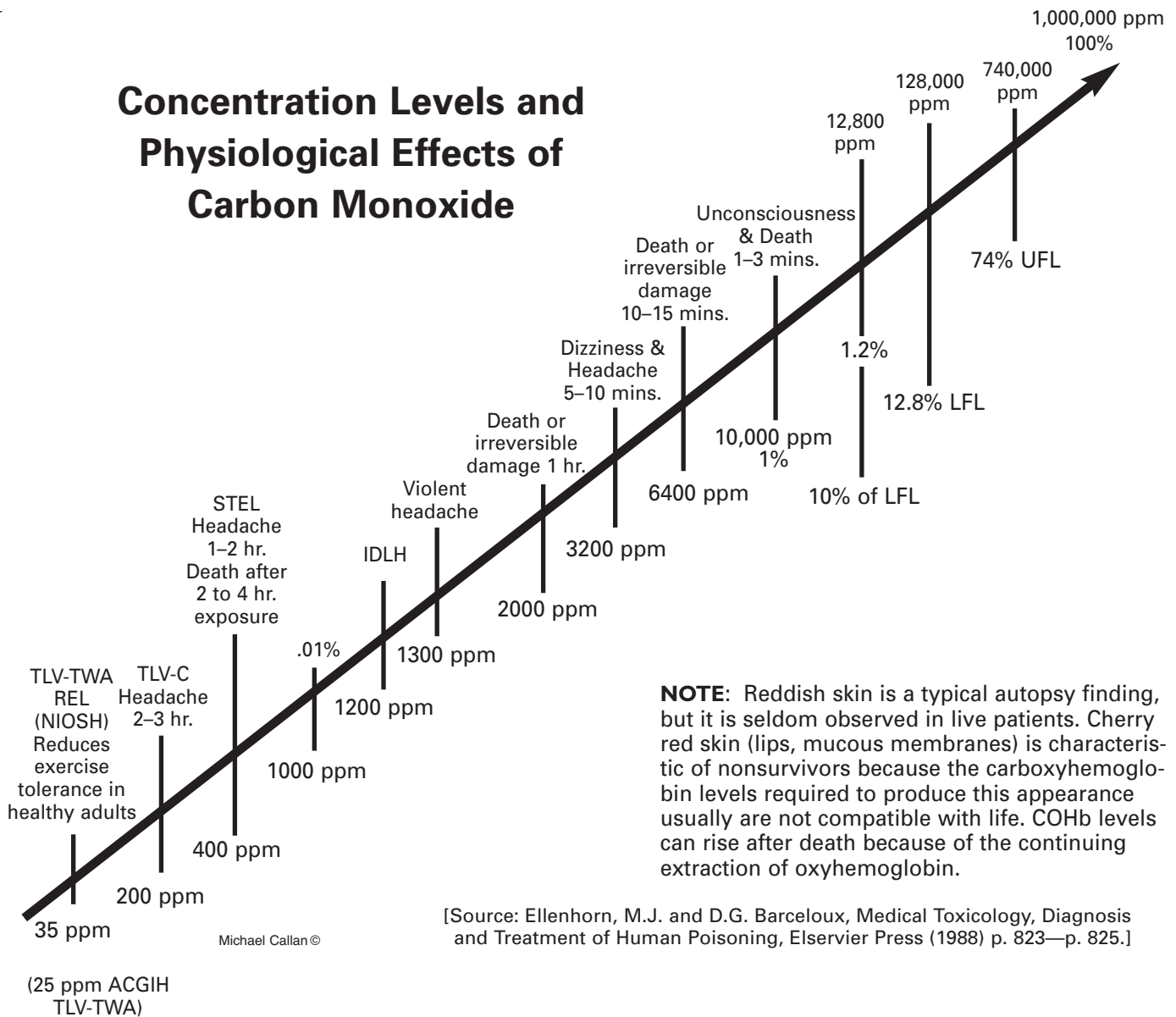


FIGURE 8-10 Concentration levels and physiological effects of carbon monoxide.

NOTE TO EMTs AND PARAMEDICS: Carbon monoxide easily binds itself to the hemoglobin molecule. It has an affinity for hemoglobin 200 times that of oxygen. Once bound, receptor sites on the hemoglobin can no longer transport oxygen to the peripheral tissues. The result is hypoxia at the cellular level and, ultimately, metabolic acidosis. Hyperbaric oxygen increases the PaO_2 , which promotes increased oxygen uptake on parts of the hemoglobin molecule which has not yet been bound by carbon monoxide. (Source: *Paramedic Emergency Care*, 3rd edition, by Bledsoe, Porter, and Shade, pp. 596–597.)

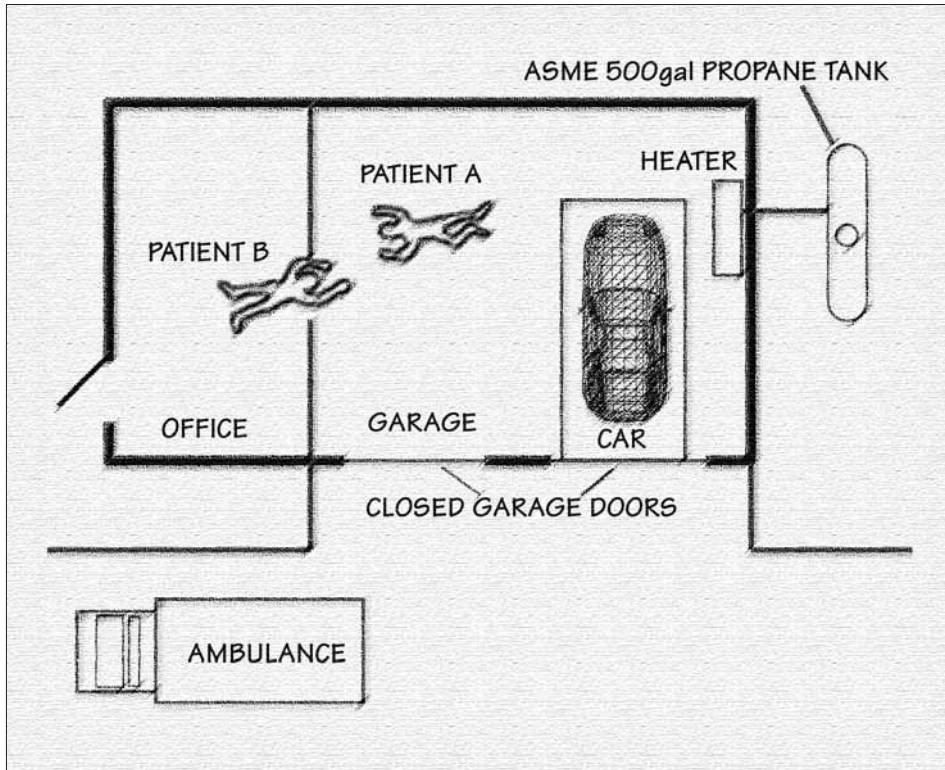


FIGURE 8-11